UNIVERSITY OF SASKATCHEWAN

College of Engineering

G.E. 120.3

Introduction to Engineering II

FINAL EXAMINATION #2

April 26, 2002

9:00 AM - 11:00 AM

STUDENT NAME: ______________________________

STUDENT NUMBER: ______________________________

LECTURE SECTION:
- L02 Tu-Th 11:30 – 1:00 Prof. H.C. Wood
- L04 Tu-Th 1:00 – 2:30 Prof. T.G. Crowe
- L06 Tu-Th 2:30 – 4:00 Prof. T.C. Muench

Question 1	/ 15
Question 2	/ 5
Question 3	/ 15
Question 4	/ 15
Question 5	/ 5
Question 6	/ 15
Question 7	/ 15
Question 8	/ 15
TOTAL	/ 100

GENERAL INSTRUCTIONS FOR THE QUESTIONS

1) **NO** textbooks, **NO** notes, **NO** assignments, and **NO** laboratory logbooks/reports.
2) **NO calculators allowed**.
3) Neatness counts. Please ensure your paper is readable.
4) Some questions contain special instructions. Please ensure that you read these carefully.
5) Not all questions are of the same difficulty and value. Consider this when allocating time for the solution.
6) *IF A QUESTION PROVES TO BE TOO HARD FOR YOU TO SOLVE, GO ON TO ANOTHER QUESTION! RETURN TO THE TROUBLESOME QUESTION WHEN TIME PERMITS.*

PLEASE NOTE

ALL parts of the examination paper MUST be handed in before leaving.

Please check that your examination paper contains 11 pages TOTAL.

QUESTION #1

MARKS: 7 (7)

Two engineering students want to measure the width of a lake in northern Saskatchewan, from point A on one side to point B on the other side. At the same time, one student starts rowing his canoe from point A towards point B at a certain constant speed, and the second student starts rowing her canoe from point B towards point A at a different but constant speed. They pass each other 800 meters from point A. When each of them reaches the opposite shore, they immediately turn around and return to their starting points rowing at the same speed as on the original crossing. They again pass when they are 300 meters from point B.

How wide is the lake? (Ignore accelerations at the beginning and end, and assume each has a constant speed for the whole trip)

QUESTION #2

MARKS: 9 (3+3+3)

1) In the Civil Engineering lab, it wasn't important to maintain high resolution (a lot of decimal places) in the calculations because there were numerous estimations, approximations and assumptions leading up to the problem definition. List 2 of these (estimations, approximations and assumptions).

2) As part of the Engineering Physics lab, groups were asked to record the location of specific points on the U of S campus, as a minimum.
   a) In what quadrant of the globe is Saskatoon (i.e. east or west of the prime meridian and north or south of the equator)?
   b) Based on the Cartesian axes that were incorporated in the exercises in the Engineering Physics lab, in which octant was Saskatoon (i.e. were each of the X, Y and Z coordinates positive or negative)?

3) When completing the calculations for the Chemical Engineering lab, an energy balance in the evaporator was used to determine the amount of steam required for producing the annual quota of "light" beer. Which stream(s) "delivered" energy to the evaporator and which stream(s) allowed energy to exit the evaporator?

QUESTION #3

MARKS: 12 (4+4+4)

The point **p** = (3, -4) in the xy-plane is to be transformed using a series of 2D geometrical transformations. It is to be scaled using S_x = -2 and S_y = 2, then rotated -90°, and then translated by T_x = 9 and T_y = -5.

What are the new coordinates of the point **p'**? <u>All work must be clearly shown, and also show the intermediate points, approximately to scale, on an x-y plot.</u>

QUESTION #4

MARKS: 15 (3+3+3+3+3)

Answer each of the following where **u** = [2 -3 4] and **v** = [-2 -3 5].

a) **u** · **v**

b) **u** x **v**

c) Cos θ, where θ is the angle between **u** and **v**

d) Sin θ, where θ is angle between **u** and **v**

e) The projection (vector) of **u** on **v**

QUESTION #5

MARKS: 5 (5)

Given two points **u** = [6 3 1] and **v** = [2 2 1] and the line g^T = [3 -4 2], find which point is on the line and the distance from the other point to the line.

QUESTION #6

MARKS: 15 (3+3+3+3+3)

Answer each of the following questions.

a) Find all solutions to the equation: $x^2 - 4x + 5 = 0$

b) Evaluate the following expression and present the solution in rectangular **and** polar forms.
$(2+3i)*(1-2i)$

c) Evaluate the following expression and present the solution in rectangular **and** polar forms.
$\frac{1+i\sqrt{3}}{1-i\sqrt{3}}$

d) Evaluate the following expression and present the solution in **either** rectangular **or** polar form.

$$(1-i)^8$$

e) Evaluate the following expression and present the solution in **either** rectangular **or** polar form.

$$e^{-1+\frac{ip}{2}}$$

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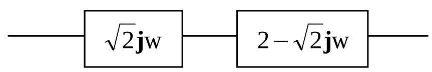
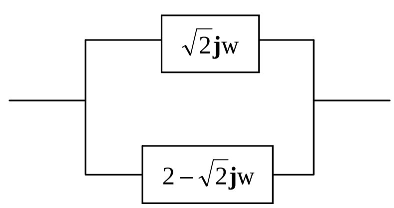
QUESTION #7

MARKS: 15 (6+9)

Answer each of the following questions.

We know that the equivalent resistance of 2 resistors ($\mathbf{R}_1$ and $\mathbf{R}_2$) in series can be evaluated by $\mathbf{R}_1 + \mathbf{R}_2$. Likewise, 2 resistors in parallel have an equivalent resistance of $\dfrac{\mathbf{R}_1\mathbf{R}_2}{\mathbf{R}_1 + \mathbf{R}_2}$. Given that complex impedances can be treated in similar ways, calculate the equivalent impedance of the following networks, where the complex impedances of the individual components have been identified. Express each equivalent impedance in rectangular **and** polar forms.

a) 

b) 

QUESTION #8

MARKS: 15 (5+5+5)

Engineers are concerned that the spring melt this year will take out a bridge on the river. They have the following information available:

-The bridge deck is horizontal with one 60-meter span from one vertical abutment to the other

-At end A, the river bed meets the abutment 2.0 m below the bottom of the deck of the bridge

-At the other end, the river bed meets the abutment 1.0 m below the bottom of the deck. The abutments define the widest part of the flow beneath the bridge.

-At distances of 10, 20, 30, 40, and 50 m from end A, the river bed is 6, 14, 22, 21, and 13 meters below the bottom of the deck of the bridge, respectively.

-The flow velocity when the river is full (water to the bottom of the deck) is 1.0 m/s, assumed uniform over width and depth.

a) What is the maximum flow capacity of the river in m^3/s ?

b) Currently, the water is 10 m below the bottom of the deck of the bridge, and flowing at a uniform speed of 0.5 m/s. What is the flow rate of the river now?

c) Reservoir engineers estimate that over a 3 day period next week, the equivalent of 3 cm average depth of melt water from a watershed of 550,000 hectares will enter the river at a uniform rate. (there are 100 hectares in l km^2 of land). Can the river handle this extra flow without water impacting the bridge deck?